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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	11SW-4908
First Inventor	Peter J. Radusewicz
Title	AUTOMATIC TRANSFER SWITCH SYSTEMS AND CONTROLLERS
Express Mail Label No.	EL319733920US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. Fee Transmittal Form (e.g., PTO/SB/17)
(Submit an original, and a duplicate for fee processing)

2. Application claims small entity status.
See 37 CFR 1.27

3. Specification [Total Pages]
(Preferred arrangement set forth below)

- Descriptive title of the Invention
- Cross References to Related Applications
- Statement Regarding Fed sponsored R & D
- Reference to sequence listing, a table, or a computer program listing appendix
- Background of the Invention
- Brief Summary of the Invention
- Brief Description of the Drawings (if filed)
- Detailed Description
- Claim(s)
- Abstract of the Disclosure

4. Drawing(s) (35 USC 113) [Total Sheets]

5. Oath or Declaration [Total Pages]

a. Newly executed (original or copy)

b. Copy from a prior application (37 CFR 1.63(d))
(for continuation/divisional with Box 18 completed)

i. DELETION OF INVENTOR(S)
Signed statement attached deleting inventor(s)
named in the prior application, see 37 CFR
1.63(d)(2) and 1.33(b).

6. Application Data Sheet. See 37 CFR 1.76

Assistant Commissioner for Patents
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Washington, DC 20231

7. CD-ROM or CD-R in duplicate, large table or
Computer Program (Appendix)

8. Nucleotide and/or Amino Acid Sequence Submission
(If applicable, all necessary)

a. Computer Readable Form (CRF)

b. Specification Sequence Listing on:

- i. CD-ROM or CD-R (2 copies); or
- ii. paper

c. Statements verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

9. Assignment Papers (cover sheet & document(s))

10. 37 CFR 3.73(b) Statement
(when there is an assignee) Power of Attorney

11. English Translation Document (if applicable)

12. Information Disclosure Statement (IDS)/PTO-1449 Copies of IDS
Citations

13. Preliminary Amendment

14. Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)

15. Certified Copy of Priority Document(s)
(If foreign priority is claimed)

16. Request and Certification under 35 U.S.C. 122
(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or
its equivalent.

17. Express Mail Certificate

18. Other: _____

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18. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1.76:

Continuation Divisional Continuation-in-part (CIP) of prior application No.: _____ / _____

Prior application information

Examiner: _____

Group/Art Unit: _____

For CONTINUATION OR DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

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Signature		Date	December 29, 2000

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FEE TRANSMITTAL for FY 2001

Patent fees are subject to annual revision.

TOTAL AMOUNT OF PAYMENT	(\$ 854.00)	Attorney Docket Number	11SW-4908
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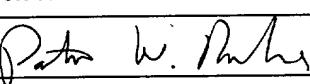
Application Number	
Filing Date	
First Named Inventor	Peter J. Radusewicz
Group Art Unit	
Examiner Name	

METHOD OF PAYMENT (check one)				FEES CALCULATION (continued)																																																																																																																																																														
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SUBMITTED BY				Complete (if applicable)	
Name (Print/Type)	Patrick W. Rasche	Registration No. (Attorney/Agent)	37,916	Telephone	(314) 621-5070
Signature				Date	December 29, 2000

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11SW-4908

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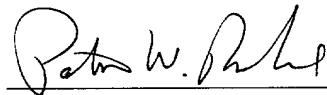
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I certify that the attached utility patent application of **Peter J. Radusewicz** (Attorney Docket No. 11SW-4908) for **AUTOMATIC TRANSFER SWITCH SYSTEMS AND CONTROLLERS** including:

- Six (6) pages of specification; five (5) pages of claims; one (1) page of abstract
- Two (2) sheets of drawings
- Patent Application Transmittal (1 page)
- Fee Transmittal (in duplicate) (1 page)
- Declaration and Power of Attorney (2 pgs.)
- Recordation Form Cover Sheet (1 pg.) (in duplicate)
- Assignment (1 pg.)
- Certificate of Mailing Via Express Mail (1 page)
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314/621-5070

AUTOMATIC TRANSFER SWITCH SYSTEMS AND CONTROLLERS

BACKGROUND OF THE INVENTION

This invention relates generally to electrical switches and, more particularly, to automatic transfer switches and control thereof.

Many businesses use transfer switches for switching power sources, for example, from a public utility source to a private secondary supply, automatically within a matter of seconds. Critical load businesses, such as, for example, hospitals, airport radar towers, and high volume data centers are dependent upon automatic transfer switches to provide continuous power. Transfer switches typically utilize a plurality of contacts that can be open or closed.

Typically, automatic transfer switches are controlled using relay logic, programmable logic controllers (PLCs) or embedded controllers. In known systems, the embedded controller monitors the public utility power source for a fault condition. Upon recognizing any one of a number of faults with the utility power, the embedded controller is configured to switch in the secondary source of power, typically a generator, via the transfer switches.

Known automatic transfer switch controllers incorporate external components to accomplish the control task and require hardware and software redesigns when making input/output (I/O) changes. Further, known automatic transfer switch controllers are unable to communicate with external devices for software selection of options.

Accordingly, it would be desirable to provide systems for automatic transfer switch control which eliminate external components and provide flexibility for I/O circuit redesign. It would be further desirable to have an automatic transfer switch controller with a communications interface to enable and select software options from an external device.

BRIEF SUMMARY OF THE INVENTION

An automatic transfer switch controller includes a power supply circuit to regulate and filter input power. Also included is a transformer to convert utility and generator power sources into power supply voltages and voltage sensing sources for the controller. A voltage sense signal conditioning circuit is included as is a solenoid driver circuit used to drive automatic transfer switch solenoids. The controller uses an embedded microcontroller to monitor utility and generator voltages which is interfaced to a user interface for operator entry of instructions. An LED indicator interfaced to said microcontroller is used to indicate operator entry of instructions at the operator interface.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a simplified schematic showing electrical routing within an automatic transfer switch system; and

Figure 2 is a block diagram of an automatic transfer switch controller.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 is a simplified schematic diagram 10 showing electrical routing within an automatic transfer switch (ATS) system. Included in diagram 10 are a utility source 12 and a generator source 14. Each of utility source 12 and generator source 14 are routed through circuit breakers 16 to a transfer switch 18. Transfer switch 18 is configured to route electrical power from utility source 12 through transfer switch 18 to a main breaker panel 20, through which electricity is distributed throughout a facility. Transfer switch 18 is further configured with a controller (not shown) to monitor the power from utility source 12 for power quality, for example voltage, power factor, electrical noise and the like. When the transfer switch controller senses a problem with power quality, based upon preset limits, the transfer switch controller commands transfer switch 18 to switch to electrical power from generator source 14, on a temporary basis, until the transfer switch controller senses that the power quality from utility source 12 has returned to an acceptable level.

Figure 2 is a block diagram of an automatic transfer switch controller 40. Controller 40 includes a microcontroller 42, a memory 44, a user interface 46, a power input section 48, an output section 50 which is configured to command one or more transfer switches 18 (shown in Figure 1) to go to power from a generator source or to return to a utility source of power. Controller 40 also includes a configuration section 52, a communications port 54 and a multi-function input/output (I/O) port 56 described below in more detail.

The term microcontroller, as used herein, also refers to microprocessors, reduced instruction set circuits (RISC), application specific integrated circuits (ASICs), logic circuits, and any other circuit or processor capable of executing the programs described above.

Controller 40 is a low cost, high performance ATS controller with software selectable options. In one exemplary embodiment, software options are to be enabled or disabled through the use of a factory configuration program via port 54, which is for example, an RS232 port.

Controller 40 is configured with external connections (not shown in Figure 2) to allow for adaptation of multiple function input/output (I/O) boards. I/O boards give controller 40 a modular configuration where different options can be made available to the end user if needed.

In one exemplary embodiment, functions of controller 40 are implemented on a main control circuit board which includes control and conditioning circuits as described below.

Power input section 48 includes transformers to convert power from utility source and generator source 14 (both shown in Figure 1) into power supply voltages for powering controller 40 and into voltages to be sensed by controller 40. Power input section 48 regulates and filters raw supply voltages from the transformers before it is applied to the main control board of controller 40 and any optional I/O boards such that correct operating voltages and currents are applied to such boards.

5 Power input section 48 further includes a voltage sense signal conditioning circuit which uses low pass filtering techniques to remove all unwanted noise from the raw voltage supply before it is applied to analog-to-digital converter (ADC) pins on microcontroller 42. Filtering allows controller 40 to correctly sense voltage and frequency when utility source 12 or generator source 14 contain large amounts of harmonic distortion.

10 In another exemplary embodiment of controller 40, output section 50 is configured as a solenoid driver circuit which includes two options of solenoid drivers, both of which are implemented on the main control board. A first solenoid driver option is configured with on-board relays when the utility and generator power sources are 240Vac and below. A second solenoid driver option is configured with solid state devices when the utility and generator power sources are greater than 240Vac, but less than 600 Vac. The solenoid driver circuit is used to control the power supplied to an ATS drive solenoid which causes switching from one electrical power source to another in transfer switch 18 (shown in Figure 1).

15 Using user interface 46 a user can momentarily energize a normal output causing the ATS to transfer to normal position, the position where utility power is used. Momentarily energizing an emergency output causes the ATS to transfer to the position where generator power is used. In order to protect the ATS drive solenoid from damage, a solenoid saver scheme is implemented in controller 40 which controls the maximum on time and the number of tries a drive solenoid can be energized for before shutting down the drive circuit and initiating a diagnostic mode.

20 All functions on the main control board are controlled by microcontroller 42 which uses custom written firmware to monitor the utility and generator voltages and frequency, monitor user interface updating indicator LEDs on user interface 46, perform real time clock functions, monitor ATS position and control the ATS. Microcontroller 42 also monitors and controls all external I/O connections used to control any auxiliary I/O boards. In a further embodiment, controller 40 is configured with a generator cool down timer, a generator warmup timer, a loss of power delay timer, a generator fail-to-start timer, a generator crank timer, a generator

pause timer, a generator overload timer and an utility stabilization before switchback timer.

Controller 40 includes a configuration section 52. In one embodiment, configuration section 52 includes a jumper panel. Jumpers are installed by a user to 5 select one of a seven, 14, 21, or 28 day cycle for a built in ATS exerciser. The exerciser period can be adjusted for seven, 14, 21, or 28 days by selecting the appropriate jumpers setting located on the main control board.

Configuration section 52 further includes jumper selectable voltage and frequency selections. The voltage controller 40 can sense is selectable from 120, 208, 10 220, and 240 Vac through the use of the correct jumper settings. Voltage ranges in the 380, 415, 440, and 480Vac are also selectable, but require that a different transformer be used in controller 40. Jumpers are also available for frequency selections of 50 Hz and 60 Hz.

Controller 40 is further configured with a passive load shed option 15 which, when coupled with a load shed I/O option board will disconnect certain high kilowatt loads before the controller transfers loads from utility power to generator power, thereby preventing unwanted loads from over loading generator 14.

In another embodiment, controller 40 is configurable with a generator control board (not shown) option which is an optional I/O board that connects to the 20 main control board and contains I/O functions which are accessible at I/O port 56. Examples of I/O functions include, but are not limited to oil pressure sensing, temperature sensing, and a set of dry contacts for starter motor control including a fuel/run contact output and a start contact output. When a generator control board is included in controller 40, a software control bit is enabled to allow access to the board 25 I/O functions.

In still another embodiment, controller 40 is configurable with a three phase sense board (not shown). The three-phase sense board is an optional I/O board that expands controller 40 from single-phase voltage sensing to three-phase voltage

sensing on both utility and generator power sources. The three-phase sense board contains all of the necessary conditioning circuitry necessary for proper voltage and frequency detection.

Controller 40 solves problems present in known controllers. Such problems include external relay transformer boxes separate from the controller, a need for an external exerciser clock and the ability to make I/O changes without complete redesign of the ATS controller. In addition, controller 40 locates all ATS control components and voltage conditioning components on a main control board, thereby allowing for other I/O functionality to be implemented on option boards as described above.

While the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.

WHAT IS CLAIMED IS:

1. An automatic transfer switch controller comprising:

a power supply circuit to regulate and filter input power;

at least one transformer to convert utility and generator power sources into power supply voltages and voltage sensing sources;

5 a voltage sense signal conditioning circuit;

a solenoid driver circuit to drive automatic transfer switch solenoids;

an embedded microcontroller configured to control logic functions and to monitor utility and generator voltages and frequencies;

10 a user interface to said microcontroller for operator entry of instructions; and

at least one LED indicator interfaced to said microcontroller to indicate operator entry of instructions at said user interface.

2. A controller according to Claim 1 wherein said microcontroller comprises at least one analog-to-digital converter.

15 3. A controller according to Claim 2 wherein said voltage sense signal conditioning circuit comprises low pass filters configured to remove noise from the power supply thereby enabling said microcontroller analog-to-digital converter to correctly sense voltage and frequency.

20 4. A controller according to Claim 1 wherein said solenoid driver circuit is configured with relays for powering automatic transfer switch drive solenoids.

5. A controller according to Claim 1 wherein said solenoid driver circuit is configured with solid state devices for powering automatic transfer switch drive solenoids.

5 6. A controller according to Claim 1 wherein said microcontroller is configured to recognize jumper selections for an exerciser clock adjustable for settings for a preselected number of days.

10 7. A controller according to Claim 1 wherein said microcontroller is configured to recognize jumper selections for supply voltages for at least one of 120 VAC, 208 VAC, 220 VAC and 240 VAC.

15 8. A controller according to Claim 1 wherein said transformer is configured for supply voltages of at least one of 380 VAC, 415 VAC, 440 VAC and 480 VAC, said microcontroller is configured to recognize jumper selections for supply voltages for at least one of 380 VAC, 415 VAC, 440 VAC and 480 VAC.

15 9. A controller according to Claim 1 further comprising a generator control board configured to interface with said microcontroller and to sense at least one of oil pressure and temperature.

20 10. A controller according to Claim 9 wherein said generator control board is configured with a set of dry contact outputs for starter motor control including at least one of a fuel/run contact output and a start contact output.

20 11. A controller according to Claim 1 further comprising a three phase sense board configured to expand single phase sensing capabilities of said controller to three phase sensing on utility and generator sources.

25 12. A controller according to Claim 1 further comprising a load shed I/O option board configured to disconnect loads before said controller transfers loads to a generator power source, preventing generator over load.

13. A controller according to Claim 1 wherein said microcontroller is configured with at least one of a generator cool down timer, a generator warmup

timer, a loss of power delay timer, a generator fail-to-start timer, a generator crank timer, a generator pause timer, a generator overload timer and an utility stabilization before switchback timer.

14. A controller according to Claim 1 wherein said microcontroller
5 is configured to recognize jumper selections for frequencies of 50 Hz and 60 Hz.

15. An automatic transfer switch system comprising:

an input configured to be connected to a utility power source;

an input configured to be connected to a generator power source;

10 a transfer switch configured to switch a load from said utility power source to said generator power source and further configured to switch the load back to said utility power source; and

an automatic transfer switch controller comprising:

a power supply circuit to regulate and filter input power;

15 at least one transformer to convert utility and generator power sources into power supply voltages and voltage sensing sources;

a voltage sense signal conditioning circuit;

a solenoid driver circuit to drive automatic transfer switch solenoids;

20 an embedded microcontroller configured to control logic functions and to monitor utility and generator voltages and frequencies;

a user interface to said microcontroller for operator entry of instructions; and

at least one LED indicator interfaced to said microcontroller to indicate operator entry of instructions at said user interface.

16. An automatic transfer switch system according to Claim 15 wherein said microcontroller further comprises at least one analog-to-digital converter.

5 17. An automatic transfer switch system according to Claim 16 wherein said voltage sense signal conditioning circuit comprises low pass filters configured to remove noise from the power supply thereby enabling said microcontroller analog-to-digital converter to correctly sense voltage and frequency.

10 18. An automatic transfer switch system according to Claim 15 wherein said solenoid driver circuit is configured with relays for powering automatic transfer switch drive solenoids.

15 19. An automatic transfer switch system according to Claim 15 wherein said solenoid driver circuit is configured with solid state devices for powering automatic transfer switch drive solenoids.

20. An automatic transfer switch system according to Claim 15 wherein said microcontroller is configured to recognize jumper selections for an exerciser clock adjustable for a preset number of days.

15 21. An automatic transfer switch system according to Claim 15 wherein said microcontroller is configured to recognize jumper selections for supply voltages for at least one of 120 VAC, 208 VAC, 220 VAC and 240 VAC.

20 22. An automatic transfer switch system according to Claim 15 wherein said transformer is configured for supply voltages of at least one of 380 VAC, 415 VAC, 440 VAC and 480 VAC, said microcontroller is configured to recognize jumper selections for supply voltages for at least one of 380 VAC, 415 VAC, 440 VAC and 480 VAC.

25 23. An automatic transfer switch system according to Claim 15 wherein said controller further comprises a generator control board configured to

interface with said microcontroller and to sense at least one of oil pressure and temperature.

24. An automatic transfer switch system according to Claim 23 wherein said generator control board is configured with a set of dry contact outputs for 5 starter motor control including at least one of a fuel/run contact output and a start contact output.

25. An automatic transfer switch system according to Claim 15 wherein said controller further comprises a three phase sense board configured to 10 expand single phase sensing capabilities of said controller to three phase sensing on utility and generator sources.

26. An automatic transfer switch system according to Claim 15 wherein said controller further comprises a load shed I/O option board configured to disconnect loads before said controller transfers loads to a generator power source, preventing generator over load.

15 27. An automatic transfer switch system according to Claim 15 wherein said microcontroller is configured with at least one of a generator cool down timer, a generator warmup timer, a loss of power delay timer, a generator fail-to-start timer, a generator crank timer, a generator pause timer, a generator overload timer and an utility stabilization before switchback timer.

20 28. An automatic transfer switch system according to Claim 15 wherein said microcontroller is configured to recognize jumper selections for frequencies of 50 Hz and 60 Hz.

AUTOMATIC TRANSFER SWITCH SYSTEMS AND CONTROLLERS

ABSTRACT OF THE DISCLOSURE

An automatic transfer switch (ATS) controller is disclosed which includes a power supply circuit to regulate and filter input power, a transformer to convert utility and generator power sources into power supply voltages and voltage sensing sources and a voltage sense signal conditioning circuit. Controller further implements a solenoid driver circuit to drive automatic transfer switch solenoids, an embedded microcontroller configured to monitor utility and generator voltages and a user interface interfaced to said microcontroller for operator entry of instructions. A LED indicator is included and is configured to verify user interface entries and overall operation of the controller and ATS system.

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11SW-4908

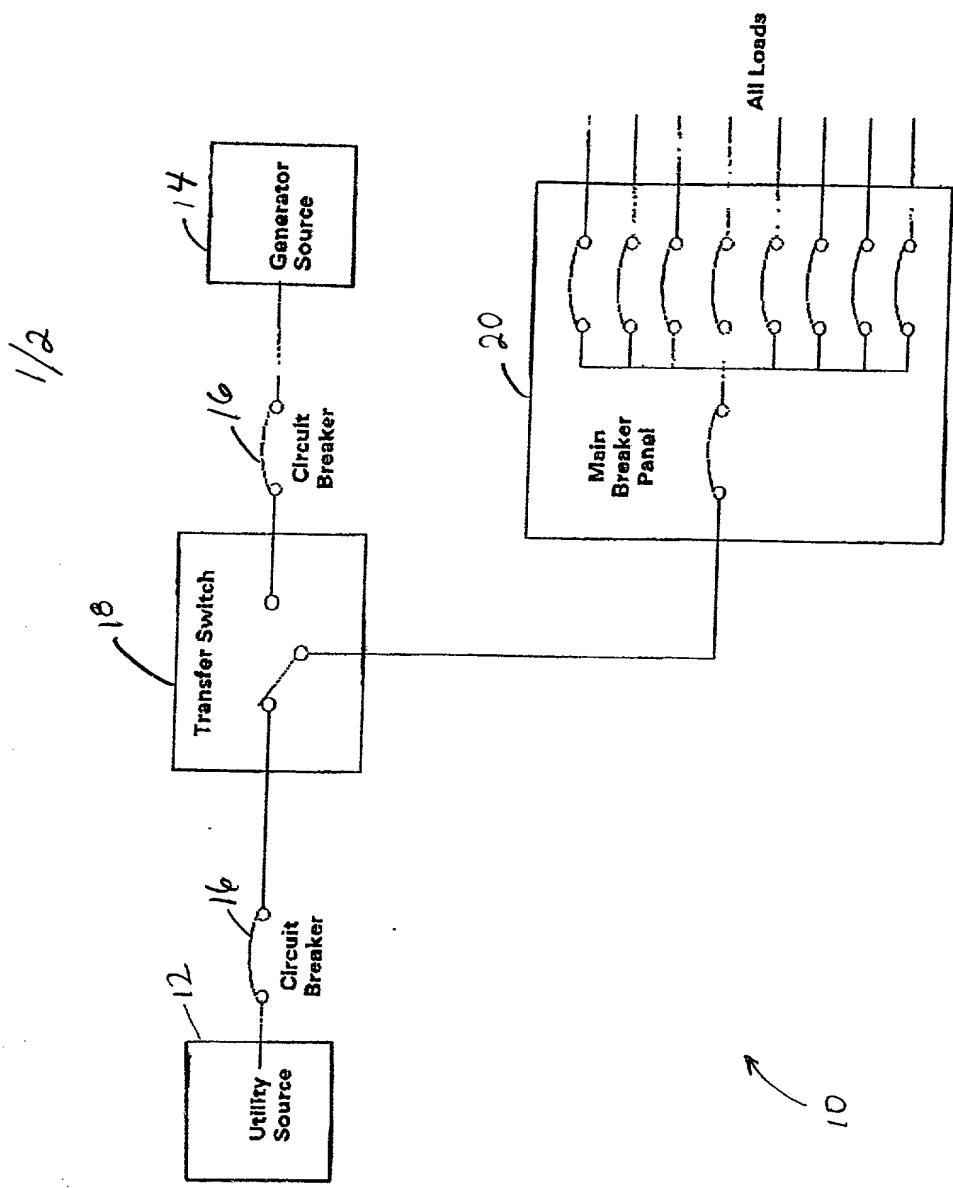
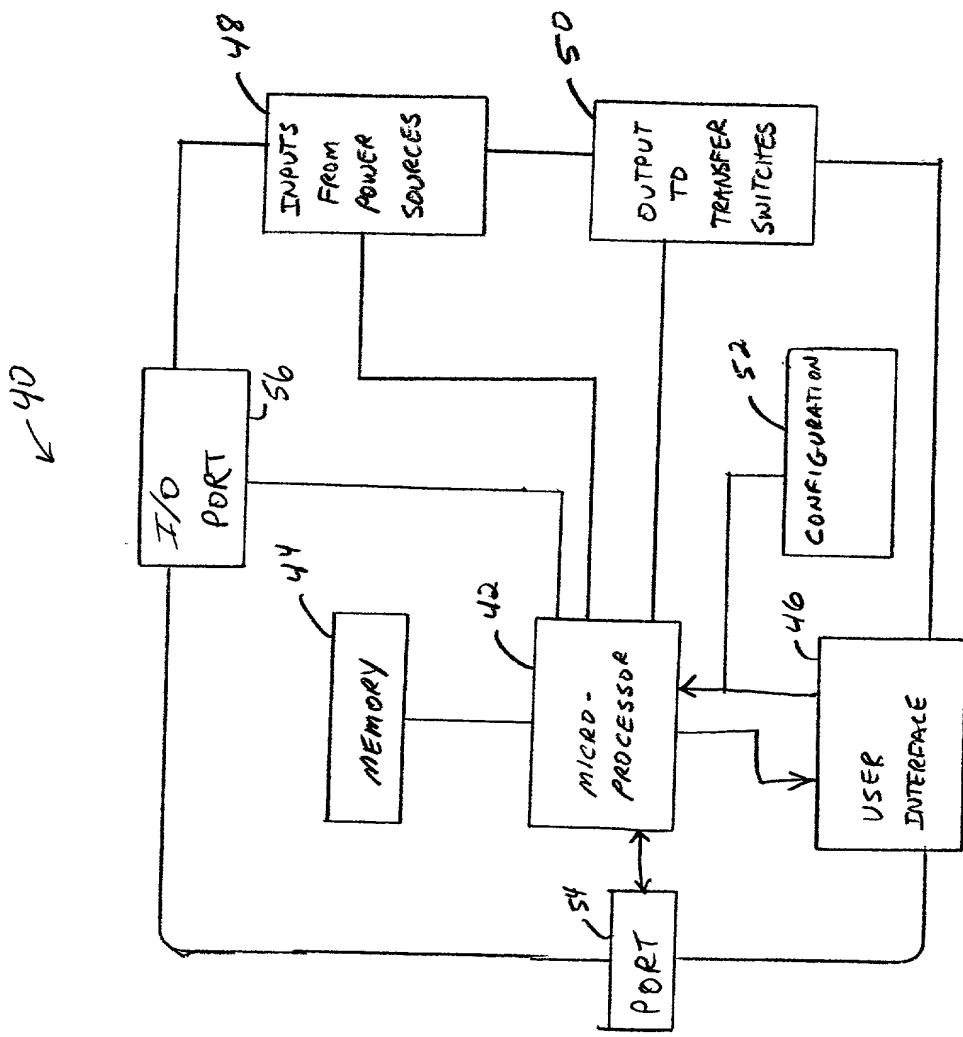


FIG. 1

2/2

FIG. 2



COMBINED DECLARATION AND POWER OF ATTORNEY**Attorney Docket No.
11SW-4908**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: **AUTOMATIC TRANSFER SWITCH SYSTEMS AND CONTROLLERS, (Docket No. 11SW-4908)** the specification of which:

(check one) is attached hereto
 was filed on _____ as Application Serial No. _____,
and was amended on _____.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations §1.56(a).

I hereby claim priority benefits under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112. I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

<u>Application Serial No.</u>	<u>Filing Date</u>	<u>Status (patented, pending, abandoned)</u>
_____	_____	_____
_____	_____	_____
_____	_____	_____

I hereby claim the benefit under Title 35, United States Code §119(e) of any United States provisional application(s) listed below:

<u>Application Serial No</u>	<u>Filing Date</u>	<u>Additional provisional application numbers are listed on a supplemental priority sheet attached hereto.</u>
_____	_____	_____
_____	_____	_____
_____	_____	_____

I hereby appoint Ronald E. Myrick, Reg. No. 26,315; Henry J. Policinski, Reg. No. 26,621, Jay L. Chaskin, Reg. No. 24,030; Henry I. Steckler, Reg. No. 24,139; and James W. Mitchell, Reg. No. 25602, all of General Electric Company, 3135 Easton Turnpike, Fairfield, CT 06431; Carl B. Horton, Reg. No. 34,622; Damian G. Wasserbauer, Reg. No. 34,749; and Dave S. Christensen, Reg. No. 40,955, all of General Electric Company, 41 Woodford Avenue, Plainville, CT 06062; and John S. Beulick, Reg. No. 33,338 and Patrick W. Rasche, Reg. No. 37,916, all of Armstrong Teasdale LLP, One Metropolitan Square, Suite 2600, St. Louis, MO 63102, jointly, and each of them severally, my attorneys and attorney, with full power of substitution, delegation and revocation, to prosecute this application, to make alterations and amendments therein, to receive the patent and to transact all business in the Patent and Trademark Office connected therewith.

I hereby direct that all correspondence and telephone calls in connection with this application be addressed to the said

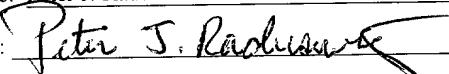
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COMBINED DECLARATION AND POWER OF ATTORNEY**Attorney Docket No.
11SW-4908**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application and any patent issued thereon.

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THIRD JOINT INVENTOR, IF ANY:

Full Name: _____

Signature: _____

Date: _____

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Citizenship: _____

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